

REMARKS

In the Office Action mailed on April 28, 2009, previous rejections of the claims were withdrawn in light of arguments made in Amendment B. New rejections of claims 1-2, 5-24 and 51 have been made under §103(a) over Hampden-Smith in view of Ha et al., J. of Power Sources 112 (2002) 655-659 (the “Ha reference”). Claims 3-4 are rejected as obvious under §103(a) over these two references in further view of U.S. Patent 3,297,487 to Pomeroy. These rejections are traversed for the reasons set forth below.

A. THE HA REFERENCE IS NOT PRIOR ART TO AT LEAST CLAIMS 1-9, 16-20, AND 23-24, AND THE OBVIOUSNESS REJECTION OF THESE CLAIMS THAT RELIES ON HA MUST THEREFORE BE WITHDRAWN

The obviousness rejections of all claims cites the Ha reference. The Ha reference is believed to have a publication date no earlier than September, 2002. The present application claims priority on several applications, including U.S. Provisional Application 60/369,992 filed on April 4, 2002 (“the ‘992 Provisional”). Because the ‘992 Provisional was filed earlier than the Ha reference was published, the Ha reference is not prior art to the ‘992 Provisional and the Ha reference cannot be cited as a prior art to presently claimed subject matter that is present in the ‘992 Provisional.

It is submitted that the subject matter of at least claims 1-9, 16-20, and 23-24 are supported in the ‘992 Provisional. The obviousness rejections of these claims is therefore improper and must be withdrawn. No admission is made regarding the disclosure of the subject matter of other claims in the ‘992 Provisional.

B. CLAIMS 21-22 ARE ALLOWABLE: HA FAILS TO DISCLOSE OR SUGGEST THE RECITED POWER DENSITY

Claims 21-22 depend from claim 1 and further recite that the cell is capable of generating a power density of at least about 150 mW/cm^2 (claim 21) and of at least about 270 mW/cm^2 (claim 22) when operating at about 21°C . Claims 21-2 stand rejected as obvious over Hampden-Smith in view of the Ha reference. The Office Action admits that Hampden-Smith fails to disclose a formic acid fuel solution or the recited power densities of claims 21-22, but alleges the Ha reference to disclose these elements. Specifically, the Office Action states: "... (the Ha Reference) cell is capable of generating a power density of at least 150 mW/cm^2 (claims 21-22)." It is submitted that this rejection is improper on its face with regard to claim 22 since claim 22 doesn't recite a power density of " 150 mW/cm^2 " as the Office Action mistakenly alleges, but instead recites the significantly higher density of 270 mW/cm^2 . The Ha reference fails to disclose or suggest this recitation, the Office Action fails to cite any reference disclosing or suggesting this, and claim 22 is therefore allowable.

It is also submitted that claim 21 is allowable. Although the Office Action alleges the Ha Reference to disclose a formic acid cell capable of generating a power density of 150 mW/cm^2 , no such disclosure is made. Instead, the Ha reference discloses a maximum power density of 119 mW/cm^2 . See Fig. 2. Further, this is disclosed for a cell operating at 60°C : "All of the cell polarization curves were measured at 60°C ." Sect. 3, Results; see also Fig. 2. Claim 21 (as well as 22) not only recite higher power densities, but they recite producing these at a much lower temperature of 21°C . It is well known that fuel cell power densities decrease with decreasing temperature. This is another reason that the disclosure of the Ha reference is not sufficient to render claim 21 (and 22) obvious.

C. CLAIMS 10-15 AND 51 (AS WELL AS ALL OTHER CLAIMS) ARE ALLOWABLE: NO PRIMA FACIE CASE OF OBVIOUSNESS HAS BEEN ESTABLISHED SINCE IT IS IMPROPER TO COMBINE HAMPDEN-SMITH WITH THE HA REFERENCE

With regards to the obviousness rejection of claims 10-15 and 51 over Hamden-Smith in view of the Ha reference (as well as all other pending claims that are rejected over a combination of these references), it is submitted that no prima facie case of obviousness has been established. Each of these claims require (among other elements) a fuel cell having a formic acid fuel together with an anode having an electrocatalyst comprising palladium nanoparticles. Claims 10-12 recite various palladium particle diameters or radius of curvatures, claims 13-15 recite various palladium catalyst loadings, and claim 51 recites that the catalyst is essentially Pd.

In rejecting these claims, the office action admits that Hampden-Smith fails to teach the recited combinations, but alleges that Hampden-Smith teaches a membrane electrode assembly (MEA) having an electrocatalyst comprised of palladium nanoparticles used with a methanol fuel meeting the various recitations except for a formic acid fuel solution, cites the Ha reference teaches the use of formic acid fuel solution in a fuel cell, and alleges that it would have been obvious to combine the references. It is submitted that this is an improper rejection.

C.1 OBVIOUSNESS LEGAL STANDARD

The MPEP states that a prima facie case of obviousness requires, among other things, objective evidence which establishes (under a preponderance of the evidence standard), a teaching to modify the prior art reference components to construct a device substantially equivalent to that claimed. This generally encompasses two sub-steps: (1) identifying objective evidence teaching how to modify the prior art components; and (2)

identifying objective evidence teaching how to combine the modified individual components. MPEP §§2141, 2143.

The Examiner must set forth a rationale, supported by objective evidence (under a preponderance of the evidence standard), that the prior art at the time of invention provided a teaching to modify and/or combine the prior art reference components to achieve the claim at issue. *Id.* The preferable evidence is an express teaching to modify/combine within the properly defined sources of prior art. In the absence of such express teaching, an Examiner may attempt to establish a rationale to support a finding of such teaching reasoned from, or based upon, express teachings taken from the prior art. MPEP § 2144; *In re Dembiczak*, 50 U.S.P.Q. 2d 1614 (Fed. Cir. 1999).

This has been referred to as the “teaching/suggestion/motivation test” (TSM). Although a rigid application of TSM was rejected in *KSR Int’l. Co. v. Teleflex, Inc.*, 82 USPQ2d 1385 (2007), the test was not discarded. The Court simply required consideration of the general knowledge of those skilled in the art and other factors, using a common sense approach to obviousness, but also warned against overly broad findings of obviousness:

...a patent composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art. ... (I)t can be important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does. This is so because inventions in most, if not all, instances rely upon building blocks long since uncovered, and claimed discoveries almost of necessity will be combinations of what, in some sense, is already known.

Id., at 1741. The MPEP also warns against overly broad findings of obviousness based on the impermissible use of hindsight. The MPEP has set forth at least two rules that ensure against such rejections. The first is that it is impermissible to use hindsight gained from considering the application in an obviousness rejection:

... the Examiner must step backward in time and into the shoes worn by the hypothetical “person of ordinary skill in the art” when the invention was ... (made) ... Knowledge of an Applicant’s disclosure must be put aside in reaching this determination, ... The tendency to resort to “hindsight” based upon an Applicant’s disclosure is often difficult to avoid due to the very nature of the examination process.

MPEP §2142. Thus, if the only objective evidence of such teaching to modify and/or combine is found in applicant’s disclosure, no evidence of such teaching exists.

The second rule requires that an alleged advantage or beneficial result that would have been produced by a modification and/or combination of the prior art reference components must be found in objectively verifiable teachings of the prior art. MPEP §2144. Thus, to avoid the use of impermissible hindsight, these MPEP rules make clear that absent objective evidence (sufficient to satisfy the preponderance of the evidence standard), no teaching of such modification and/or combination exists.

In consideration of the above, it is submitted that the obviousness rejections of the claims is contrary to the rules set forth by the courts and the MPEP. The structure of claim 1 achieves unexpected advantages over the prior art and there has been no objective evidence put forth suggesting that one considering Hampden-Smith would have any expectation of achieving these or would be led to trying the claimed combination of a formic acid fuel solution with palladium nanoparticle catalyst. It is further submitted that the obviousness rejection of these claims over Hampden-Smith can only be made through the impermissible use of hindsight gained after considering the present application.

C.2 THE FUEL CELL OF THE REJECTED CLAIMS ACHIEVES UNPREDICTABLE AND UNEXPECTED ADVANTAGES RELATED TO THE DIMINISHMENT OR AVOIDANCE OF A CO INTERMEDIATE, AND NO OBJECTIVE EVIDENCE OF THE EXPECTATION OF THE SAME HAS BEEN PRESENTED

It is submitted the claimed combination of a formic acid fuel together with palladium nanoparticles achieves unexpected and unpredictable benefits over the prior art. As disclosed in the specification:

(a palladium nanoparticle catalyst) has been discovered to be particularly advantageous when employed in the present formic acid fuel cells because it is believed the palladium nanoparticle catalyst promotes direct formic acid oxidation and prevents poisoning of the catalyst with carbon monoxide while providing increased current and voltage efficiency.

Para 37. Also:

The results in Fig. 4 also imply that the formic acid oxidation at a palladium nanoparticle anode may have a very low activation energy. This low activation energy for oxidation of formic acid is evidence that formic acid oxidation at a palladium nanoparticle anode occurs via a direct mechanism that does not include formation of CO as an intermediate.

Para. 57. As explained in the specification and understood by those knowledgeable in the art, formation of a CO intermediate is undesirable for several reasons. These include that the CO intermediate is believed to poison the cathode and thereby reduce cell efficiency, and that CO is poisonous to humans and therefore presents hazards. Paras. 41, 43.

The avoidance or diminishment of a CO intermediate achieved by the claimed cell represents an unpredictable and unexpected benefit over prior art fuel cells that produced CO. This result is believed to occur at least partially as a result of the claimed combination of a formic acid fuel solution together with palladium nanoparticle catalyst. Hampden-Smith teaches the use of a methanol fuel solution, and therefore one knowledgeable in the technology involved would find no motivation or expectation of such an unpredictable result relating to formic acid fuel.

C.3 THE FUEL CELL OF THE REJECTED CLAIMS ACHIEVES UNPREDICTABLE AND UNEXPECTED ADVANTAGES RELATED TO POWER DENSITY AND EFFICIENCY, AND NO OBJECTIVE EVIDENCE OF THE EXPECTATION OF THE SAME HAS BEEN PRESENTED

Further, the specification discloses that the claimed fuel cell using a formic acid fuel solution together with a palladium nanoparticle catalyst yields unexpected power density and voltage efficiency. "Direct formic acid fuel cells with a palladium nanoparticles catalyst outperformed the one with the PtRu anode catalyst by more than 237% in the maximum power density and outperforms the direct methanol fuel cell with a PtRu catalyst by more than 440%." Para. 52. This increased power and efficiency may be related to the Pd catalyst's tendency to avoid formation of a CO intermediate: "the higher open cell voltage and voltage efficiency are possible in part because palladium nanoparticles catalyst selectively employ the direct method of converting formic acid to water, carbon dioxide and electricity without the production of CO intermediate. This ... means less poisoning of the catalyst by CO and therefore better catalyst performance." Para. 66.

D. NEW CLAIMS 52-54 ARE ALLOWABLE

New claims 52-54 have been presented for consideration and are believed to be allowable. These claims depend from claim 1 and further recite palladium nanoparticle catalyst particles having a radius of curvature of less than about 7.5 nm (claim 52), less than about 5 nm (claim 53), and less than about 3 nm (claim 54). No reference has been cited disclosing or suggesting these recitations with the result that the claims are allowable.

E. CONCLUSION

In conclusion, it is submitted that the claims in their present form are allowable. Timely examination and allowance are respectfully requested.

If a Petition under 37 C.F.R. §1.136(a) for an extension of time for response is required to make the attached response timely, it is hereby petitioned under 37 C.F.R. §1.136(a) for an extension of time for response in the above-identified application for the period required to make the attached response timely. The Commissioner is hereby authorized to charge fees which may be required to this application under 37 C.F.R. §§1.16-1.17, or credit any overpayment, to Deposit Account No. 07-2069.

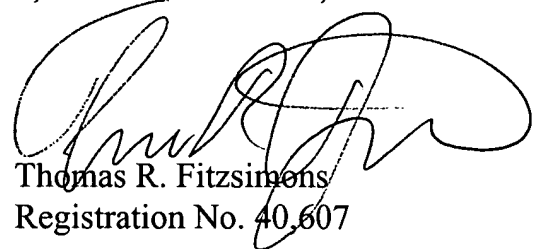
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300 South Wacker Drive, Suite 2500
Chicago, Illinois 60606
(312) 360-0080
Customer No. 24978

Respectfully submitted,

GREER, BURNS & CRAIN, LTD.

By



Thomas R. Fitzsimons
Registration No. 40,607